SECTION 552
CONCRETE STRUCTURES

552.01 DESCRIPTION. This work is constructing concrete structures, and portions of prestressed concrete, steel, timber, stone masonry, and composite structures.

552.02 MATERIALS. Furnish materials meeting the following Section and Subsection requirements.

Concrete	Section 551
Reinforcing Steel and Structural Steel	Section 711
Expansion Joint Filler	Subsection 707.01
Water Stops	Subsection 707.03
Compression Joint Seals	Subsection 711.15
Fiber-Reinforced Pads for Bearing Plates	Subsection 711.16

552.03 CONSTRUCTION REQUIREMENTS.

552.03.1 General. The classes of cast-in-place concrete used in bridge substructures, retaining walls, and superstructures are as follows:

A. Class "AS" or "DS" for foundation seals and other underwater placement;
B. Class "AD" or "DD" for retaining walls, substructure to the beam seats, backwalls, and diaphragms;
C. Class "BD Modified" for deck slabs, curbs, sidewalks, and barriers.

552.03.2 Foundations. Construct foundations meeting Section 209 requirements.

Place concrete only after the foundations are inspected and approved.

552.03.3 Falsework. Construct falsework that will support the concrete work without detrimental deformation or settlement and to the plan lines and grades.

Use piling to support falsework not on solid footings.

Temporary camber all spans allowing for shrinkage and settlement. The Contract specifies those bridges that require a permanent camber.

Provide "Tattletales" or other approved devices at locations to indicate form settlement or deflection. Adjust falsework as required to maintain plan line and grade.

Stop the work if detrimental settlement occurs in the falsework that cannot be adjusted. Remove and replace all concrete work affected by detrimental settlement at Contractor expense.

The Contractor is responsible for the adequacy and execution of the falsework plans. Furnish a Contractor approved copy of the falsework plans to the Project Manager upon request. The Contractor approval must be shown on the drawings.

552.03.4 Forms. Construct forms so their removal does not damage the concrete.

Remove all forms and form members not designated to remain in place.

The term "exposed surfaces" means those concrete surfaces that are above the finished ground line.

Use metal or plywood forms for exposed surfaces, and countersink all bolt and rivet holes. Assure the forms are mortar-tight providing a smooth finished concrete surface meeting the specified shape. Rough lumber, tongue-and-groove lumber, and steel-framed wooden panel forms may be used for surfaces not exposed in the finished structure that do not adversely affect the strength or appearance of the finished structure.

Use only one type of material in any form or group of forms for exposed concrete surfaces on similar parts of a structure.

Use filleted forms for re-entrant angles. Chamfer forms 3/4- inch (20 mm) for all exposed corners and edges with an enclosed angle of less than 120°.

Design the forms and falsework assuming the concrete has a liquid weight of 150 pounds per cubic foot (2432 kg per m^3) minimum for vertical loads and 85 pounds per cubic foot (1378 kg per m^3) minimum for horizontal pressure. Include in the design allowances for temporary construction loads.

Do not place concrete exceeding the designed form pressure.

Use forms for completed structures that are removable without disturbing adjacent forms.

Form marks must conform to the general lines of the structure. Column form marks may be horizontal or vertical or both, being as symmetrical as practical.

Provide form openings that permit ready access for form cleanout, inspection, placement, and compaction of the concrete. Provide cleanout ports at the top surface of the concrete where placing is stopped in narrow forms for walls or columns or where the bottom of the form is inaccessible.

Remove all extraneous material within the forms before placing concrete.

Treat the forms interior surfaces to prevent mortar adhesion.

Water soak wooden forms to close shrinkage cracks.

Set and maintain forms to the specified alignment, grade, and section and leave in place after concrete is placed for the specified time in Subsection 552.03.11.

Form defects are cause to stop work until corrected.

Fit metal tie rods or anchorages within the forms with cones or other devices that permit the rod and anchorage to be removed to 1-inch (25 mm) below the surface without damaging the concrete.

Use metal tie fittings that leave the smallest possible size cavities. Dry pack cavities with cement mortar to produce a sound, smooth, even finished surface closely matching that of the adjacent concrete after form removal.

Use deck slab forms that permit vertical adjustment of the bottom of the slab form.

552.03.5 Placing Concrete.

A. General. Place concrete within the specified time limits in Section 551.03.4

Use an approved set-retarding admixture when ambient temperatures are expected to exceed 60 °F (15 °C) during deck slab concrete placement. Cement content reduction is not allowed.

Maintain the concrete temperature immediately before placement between 40 °F (5 °C) and 90 °F (32 °C).

Prevent concrete segregation and displacement of the reinforcement as the concrete is placed. Thoroughly clean all chutes, troughs, and pipes

with water after each run. Discharge flushing water away from the forms and in place concrete.

Use metal or metal-lined troughs and chutes that extend to the point of deposit. Use a hopper or other device to regulate the discharge.

Do not allow concrete to drop from a height exceeding 5 feet (1500 mm) unless its within a conduit.

Support bars to maintain their position as shown in the Contract.

Deposit concrete in small quantities at many points and then work or run it along the forms. Carefully fill each part of the forms, depositing the concrete as close as possible to its final position, working the coarse aggregates back from the face and forcing the concrete under and around the reinforcing bars. Do not allow concrete to fall through or over reinforcing steel, tie rods, or similar items.

Deposit concrete around steel shapes and closely spaced reinforcing bars, on one side of the steel, uniformly working it until the concrete flushes under the steel to the opposite side before any concrete is placed on the opposite side or over the steel.

Once the concrete has taken initial set, avoid jarring the forms or straining the projecting reinforcement ends.

Thoroughly consolidate all concrete, except seal concrete, during and immediately after depositing using mechanical vibration as follows:

1. Apply the vibration internally unless otherwise approved or as provided herein.
2. Vibrate the concrete at a minimum 4500 impulses per minute or as recommended by the vibrator manufacturer.
3. The vibration must visibly affect the concrete mass producing a 1-inch (25 mm) slump over a minimum 18-inch (460 mm) radius.
4. Use enough vibrators to compact each batch immediately after its placed.
5. Vibrate the concrete around the reinforcement and imbedded fixtures and into the form corners and angles.

   Vibrate at the point of deposit in areas of freshly deposited concrete. Slowly insert and remove the vibrators from the concrete. Vibrate to thoroughly consolidate the concrete without causing segregation or forming localized grout areas.

   Vibrate at uniformly spaced points and no farther apart than twice the radius over which the vibration is visible.
6. Do not apply vibration directly to or through the reinforcement or to non-plastic sections or layers of concrete. Do not use vibrators to transport concrete in the forms.
7. Supplement vibration by spading and tamping to produce smooth surfaces and dense concrete along form surfaces, in corners and locations impractical to reach with the vibrators.
8. These requirements apply to precast piling, concrete cribbing, and other precast members unless the manufacturer's vibration methods are approved.

   Place and secure all reinforcing, dowels, and other embedded items as specified before placing the concrete. Clean rust, scale, oil,

dried mortar deposits or foreign material from all embedded materials before embedding in the fresh concrete.

Continuously place concrete in each section of the work in horizontal layers, working continuously if necessary, to prevent stoppage planes.

Place the concrete in layers to thoroughly consolidate them with the concrete beneath. Place the succeeding layer before the previous layer has reached initial set.

Compact each layer to prevent separation planes between the preceding layer and the layer being placed.

The Project Manager may require an emergency bulkhead if concrete placement in a section is delayed longer than 20 minutes.

A construction joint is any place where concrete placement has stopped and the concrete has taken initial set. Make construction joints meeting Subsection 552.03.7 requirements.

Inset construction joints where a "feather edge" might be produced in the succeeding layer. Provide a minimum thickness of 6-inches (155 mm) in all succeeding layers.

Place concrete so all construction joints are across low shear stress regions and out of view to the greatest extent possible.

B. Pumping Concrete. Use pumping equipment having the capacity required for the work and able to produce a continuous stream of concrete free of air pockets. Locate the pump to prevent vibration damage to fresh placed concrete.

Once pumping is completed, remove concrete in the pipeline to be used in the work without causing contamination or separation.

Use concrete pump discharge lines of at least a 4-inch (105 mm) diameter.

Do not permit aluminum pipe or pumping equipment with aluminum parts to contact the concrete.

C. Concrete Columns. Place concrete in one continuous operation, unless otherwise specified.

Allow columns to set at least 12 hours before placing the caps.

Place concrete in the superstructure after the column forms have been stripped and the column is inspected by the Project Manager.

The superstructure load may be placed on the columns when the column concrete reaches 80 percent of the required 28-day compressive strength, determined by testing standard 6 by 12-inch (152 X 305 mm) test cylinders.

D. Concrete Piling. Furnish concrete piling meeting Section 559 requirements.

E. Concrete Slab and Girder Spans. Place slabs and girders having spans less than 30 feet (9145 mm) in one continuous operation.

Concrete slabs with girders spanning 30 feet (9145 mm) or more may be placed in two operations, first placing the girder stems to the bottom of the slab haunches, and then placing the slab.

Use shear keys made of beveled timber blocks inserted at least 1 ½-inches (40 mm) in the fresh concrete at the top of each girder stem. Place

the blocks to uniformly cover about one-half of the girder stem top surface. Remove the blocks when the concrete has set enough to retain its shape.

Do not place the slab until the girders have been in place for at least 24 hours.

Check all falsework for shrinkage, settlement, and tighten all wedges to insure minimum deflection of the stems caused by the slab weight before placing the slab.

Place concrete in girder haunches less than 3 feet (900 mm) high at the same time as the girder stem.

When any haunch or filler has a vertical height of 3 feet (900 mm) or more, place the abutment or columns, the haunch, and the girder in 3 successive stages: first, up to the lower side of the haunch; second, to the lower side of the girder; and third, to completion.

F. Concrete Slip-forming. Concrete barrier rails on bridges may be slip-formed.

Hand finish the traffic face and top of the barrier to remove air holes and other blemishes, followed by a light broomed finish.

Sections with concrete slumps or bulges causing barrier rail misalignment or inadequate concrete cover for reinforcing steel will be rejected.

552.03.6 Depositing Concrete Underwater. Use Class "AS" or "DS" concrete for seals specified in the Contract.

All costs for concrete placed outside of the plan dimensions and any change in the seal mix design for the Contractor's convenience is at Contractor expense.

Do not place concrete underwater without Project Manager approval.

When it is impractical or inadvisable to de-water an excavation before placing concrete, place a seal course underwater to seal the cofferdam. Place the entire seal in one continuous operation, meeting the following requirements:

Use a tremie system; or pump directly into a tremie hopper; or pump directly to the deposit point.

Use tremie systems made of rigid, watertight steel tube having a minimum diameter of 10-inches (255 mm) with a hopper at the top. Keep the tremies discharge end submerged in the deposited concrete, and the tremie tube full to the hopper bottom at all times during the concrete placement. When a load is dumped into the hopper, raise the tremie to start the flow of concrete until the load discharges to the hopper bottom. Use a tremie support that allows free movement of the discharge end and permits rapid lowering of the tremie to retard or stop the flow.

Pump seal concrete meeting Subsection 552.03.5(B) requirements.

Have a backup concrete pump or tremie available at the site to insure uninterrupted placing of the entire foundation seal.

Pump concrete into a tremie meeting the placing requirements for tremie-placed concrete.

When concrete is pumped directly, the discharge tube must be a rigid pipe extending at least 5 feet (1520 mm) above the water level during placement. The discharge line from the top of the rigid pipe to the concrete pump may be flexible.

Prevent water from entering the tube while placing concrete. Fill the tubes without washing the concrete.

Place concrete in a compact mass without disturbing it once deposited.

Do not place concrete in running water or expose it to the action of water before it has reached final set. Keep water still at the point of deposit.

Do not pump from the cofferdam while depositing concrete underwater.

Make all formwork retaining concrete underwater practically watertight.

Deposit concrete to produce horizontal surfaces.

After the seal concrete has cured and can withstand the hydrostatic pressure, de-water the cofferdam and place the remaining concrete in the dry.

Prepare the top surface of the foundation seal under Subsection 552.03.7 before joining fresh concrete to the seal concrete. Remove high spots to provide the clearances for reinforcing steel or projection of embedded piling.

552.03.7 Construction Joints. Obtain the Project Managers approval for construction joint locations.

If the concrete develops initial set due to placement delays, the stopping point is considered a construction joint.

Place concrete continuously from joint to joint. Make the joints perpendicular to the principal lines of stress and locate them at points of minimum shear.

Place a gauge strip, at least 2-inches (50 mm) thick, at all horizontal construction joints and at other directed locations inside the forms along all exposed faces to provide a straight line for the joints.

Before placing fresh concrete against set concrete, draw the forms tightly against the set concrete face and remove all gage strips and key forms. Remove all latence, loose and foreign materials from the surface by sandblasting, high-pressure water cutting, or light bushhammering. Keep the surface moist until resuming concrete placement. Apply a thin coat of neat cement to the surface or coat as specified just before resuming concrete placement.

Bond the successive courses by keying or doweling, as shown in the Contract, at the top layer of each day's work and at other points where work is interrupted.

552.03.8 Joints For Bridge Approach Slabs. Construct and seal joints between concrete approach slabs and structures or concrete pavement as specified.

Use forms for joints that are removable without damaging the concrete.

Protect the joint from damage and prevent debris and foreign material from entering the joint before installing the seal.

Limit construction equipment and other vehicles operated directly across the joint to rubber-tired equipment, unless approved joint protection is used.

Repair all spalls, fractures, breaks, or voids in the concrete joint surfaces as approved.

Before placing the seal, clean the joints by abrasive blast or other similar methods, followed with high-pressure air jets to remove all residue and foreign material. Protect expansion joint filler from the blast.

Make joint surfaces surface-dry when placing the seal.

552.03.9 Cold Weather Concreting.

A. General. Assume all risk for placing concrete during cold weather. Replace frozen or damaged concrete at Contractor expense.

Cold weather is anytime the ambient temperature is expected to drop below +35 °F (1 °C).

Remove ice, snow, and frost from the forms and reinforcing bars before placing concrete. Do not place concrete on frozen ground.

B. Heating Fresh Concrete. Assure the temperature of fresh concrete is between +60 °F (15 °C) and +90 °F (32 °C) when placed.

Aggregates may be heated by steam or dry heat. Direct flame heating is prohibited. Eliminate frozen lumps, ice, and snow.

Do not add salt or chemical admixtures to the concrete to prevent freezing.

C. Protection of Concrete.

1. **General.** Maintain the air temperature surrounding fresh concrete at a minimum +60 °F (15 °C) for 7 days after placement or at a minimum +70 °F (20 °C) for 72 hours followed by +40 °F (5 °C) minimum for 96 hours. Place enclosures and heating equipment to maintain these temperatures before placing concrete.
2. **Deck Slabs and Barriers.** Protect and cure deck slabs and barriers placed after October 15 and before the following May 15 until the standard field-cured cylinders reach 90 percent of the specified minimum required strength.

   Maintain air temperatures surrounding the barriers and slabs between +50 °F (10 °C) and 120 °F (50 °C) during the cure period. Fully enclose the slabs and barriers on the tops, bottoms, and sides with space between the enclosures and the slabs and forms. Apply external heat as required to maintain the specified temperature within the enclosure.

   Insulated coverings placed directly on surfaces are not an acceptable substitute for the enclosure.

   Furnish and place recording thermometers at the locations designated by the Project Manager.
3. **Concrete Cured Under Water.** Substructure units other than those supported by falsework may be cured by a combination of heating and flooding. Maintain the air surrounding the concrete at between +60 °F (15 °C) and +120 °F (50 °C) for 72 hours after concrete placement. The unit may then be flooded with water for the remainder of the 7 day cure period if the water temperature exceeds +35 °F (2 °C). Maintain the air temperature surrounding any portion of the concrete remaining above water at +40 °F (5 °C) for the remainder of the 7 day period.

   Footings may be cured by flooding with at least 12-inches (305 mm) of water over the footing top if the water temperature stays at or above 35 °F (2 °C). Continue curing for 10 days after placement. Cure seals under water for at least 3 days before de-watering.

D. End of Curing Period. Lower the temperature within enclosures not to exceed 15 °F (10 °C) per hour until the inside and outside air temperatures are equal.

E. **Heating Equipment.** Block combustion heaters up off the concrete surface and vent them outside the enclosure. Assure heating equipment uniformly distributes heat around the concrete with the air temperature at the concrete surface never exceeding +120 °F (50 °C).

F. **Field-Cured Cylinders.** Determine the number of field-cured test cylinders, to include a minimum 6 per each days placement. Cast field-cured cylinders in single-use 6 x 12-inch (152 X 305 mm) round molds under MT-101. Protect the cylinders from moisture loss in the same manner used for the slab. Place the cylinders at the locations designated by the Project Manager and expose them to the same conditions as the slab until they are removed for testing.

Test field-cured cylinders within 36 hours after removal and not less than 5 days after casting under AASHTO T-22, except that the moist cure period is omitted. Perform tests using a certified testing laboratory. Furnish the Project Manager certified copies of the test results.

The Department may witness selected tests and testing procedures.

Two cylinders constitute a test with the test value being the average of the two compressive strengths. Continue curing and protection until the tests indicate the specified compressive strength is reached.

G. **Recording Thermometers.** Use recording thermometers that are automatic, continuous chart recording type. The range must be from +32 °F (0 °C) to at least +150 °F (65 °C) for conventional cure and +212° F (100 °C) for steam cure. Each chart must cover a minimum of 24 hours and 7 days maximum. Record only one cure period on each chart. Give the charts to the Project Manager at the end of each cure period.

Calibrate recording thermometers to the Project Manager's standard thermometer before each use and as directed.

Furnish thermometers, charts, calibration thermometers, and other equipment to maintain the thermometers.

552.03.10 Curing Concrete. Cure concrete under Subsection 551.03.6 and the applicable requirements of Subsection 552.03.9.

552.03.11 Removal of Forms and Falsework. Do not release, loosen, or remove forms or falsework without the Project Manager's approval. This approval does not relieve the Contractor of responsibility for the safety of work.

Approval to remove forms will be given when the minimum times in Table 552-1 have elapsed after placing the concrete.

The times in Table 552-1 are exclusive of days when the ambient temperature falls below 40 °F (5 °C); as the 7 day curing period is based on a minimum curing temperature of 60 °F (15 °C).

The exact time lapse before forms may be removed will be determined by the Project Manager based on the site curing conditions of the concrete.

The Contractor may request, in writing, to use high early strength cement or a richer mix to reach concrete compressive strengths earlier than the schedule shown in Table 552-1.

TABLE 552-1
MINIMUM CURE TIMES BEFORE FORM REMOVAL

ITEM	MINIMUM TIME
Walls, piers, and abutments (not yet supporting loads)	12 hours
Sides of columns, beams, and other comparable parts	12 hours
Railings (support forms)	3 days
Sidewalks on bridges	7 days
Slabs when supported on steel or wood stringers and precast concrete girders with unsupported span lengths less than 10 feet (3048 mm)	7 days
Centering under crossbeams, girders, T-beams, caps, struts, box girders, top slabs on concrete box culverts, and slabs	14 days or 80% percent of the specified 28-day strength

Remove all forms, blocks and bracing. Remove mortar lips and all irregularities caused by form joints.

The presence of honeycombed areas may cause rejection of the work, and upon written notice, require removal and rebuilding of the work in whole or part at Contractor expense.

After the forms are removed, cut back and repair all projecting wires, tie bolts, and other metal form ties passing through the concrete meeting Subsection 552.03.4 requirements.

Repair honeycombed concrete in all parts of the work and voids and depressions in exposed portions of the work as follows:

1. Chip back all coarse and broken material to a dense, uniform concrete surface with exposed solid coarse aggregate;
2. Cut back feather edges to form faces perpendicular to the surface being patched;
3. Saturate all cavity surfaces with water, and apply a thin layer of neat cement;
4. Fill the cavity with a thick mortar mixed in the same proportions as the concrete used in the work and at the same temperature as the surface against which the mortar is placed.

Use a blend of portland cement, white portland cement and sand, proportioned to match the color of the concrete being repaired. Tamp the mortar into place, and float the surface using a wooden float before initial set takes place. Cure the patch under Subsection 551.03.6.

For patching large or deep areas, add coarse aggregate to the patching material to provide a dense, well-bonded, and cured patch.

Pull or remove all falsework piling 1 foot (305 mm) below the finished ground line or streambed unless otherwise specified.

552.03.12 Finishing Concrete. Finish all exposed vertical concrete surfaces to meet the Ordinary Finish requirements in Subsection 552.03.12(A).

Finish concrete bridge deck slabs and concrete curb and sidewalk surfaces to meet the requirements of Subsections 552.03.12(E) and © respectively.

A. Ordinary Finish. An Ordinary Finish is the concrete surface left once the forms are removed and all holes caused by form ties, trapped air, and all other defects are repaired. The finished surface must be true and even, free from stone pockets, depressions, or projections beyond the surface.

Ordinary Finish is produced as follows:

1. Soak the concrete surface with water, and use the patching mortar specified in Subsection 552.03.11, working it into the small air holes and other voids in the concrete face with a sponge float or wooden float;
2. Rub off excess mortar after the mortar is partially set using burlap or carpet;
3. Remove uneven mortar surfaces that have set too hard by rubbing the entire surface with a carborundum stone and water;
4. Produce a finished surface that is uniform in texture and color.

Rub finish all surfaces not repairable by the Ordinary Finish method meeting Subsection 552.03.12(B).

The Ordinary Finish may not be required for exposed vertical concrete surfaces listed below, if the forming produces a true and uniform surface and minor defects are repaired as specified:

1. Interior surfaces of box type concrete structures such as culverts, stockpasses, and minor grade separations;
2. Concrete diaphragms for prestress girders;
3. Pier shafts, abutment walls, columns, struts, crossbeams, or other substructure components located where they are not readily subject to public access or view. In general, substructure elements on bridges in undeveloped rural areas and more than 25 feet (7620 mm) from the edge of the public road, located in or over streams not used extensively for recreation, or exclusively over railway property are not considered subject to public access and view.

Good forming practice is considered as:

1. Using materials with a smooth surface free from holes, tears, dents, and gouges;
2. Using the largest practical pieces to minimize joints;
3. Arranging joints to be vertically or horizontally symmetrical;
4. Using bracing to prevent bulges, offsets, and other major defects in the concrete surface.

Repair major surface defects, and finish the substructure unit surface or other structural components to a uniform appearance.

Major surface defects are large rock pockets, offsets at form joints exceeding 1/4-inch (6 mm), bulges, projections and depressions that deviate from the surface plane by more than 1/4-inch (6 mm) in any 4 foot (1219 mm) length, and all other defects that reduce plan reinforcing bar cover by more than 1/4-inch (6 mm).

Minor surface defects may be corrected without finishing the surrounding surface. Remove mortar fins even with the surrounding surface. Fill air holes exceeding 3/4-inch (20 mm) in the longest dimension

with mortar and strike off even with the surrounding surface. Patch minor rock pockets, tie holes, and the like as specified in Subsection 552.03.11.

B. Rubbed Finish. After concrete has hardened, saturate the surface with water and rub using a medium-coarse carborundum stone with a small quantity of mortar on its face. Approved bonding agents may be used.

Use mortar consisting of cement and fine sand in the same proportions used in the concrete being rubbed.

When forms are removed while the concrete is "green", wet the surface and rub it with a wooden float. If approved the thin mortar described above may be used for rubbing.

Continue rubbing until all form marks, projections, and irregularities are removed, all voids filled, and a uniform surface is obtained. Keep the paste produced by rubbing moist and allow it to set for at least 5 days. Smooth the surface by rubbing with a fine carborundum stone and water. Rub to produce a smooth texture and uniform color over the entire surface. After the final rubbing is complete and the surface has dried, rub the entire surface with burlap to remove loose mortar. The finished surface cannot have unsound patches, paste, powder, or objectionable marks.

C. Broomed Finish for Curbs and Sidewalks. Finish the surface of concrete curbs and sidewalks to the lines and grades in the Contract. Work the concrete until the coarse aggregate is forced into the body of the concrete and no coarse aggregate is exposed. Float the surface with a wooden float producing a smooth and uniform surface.

Apply a broom finish to curbs or sidewalks. Make the strokes square across the curb or sidewalk from edge to edge with adjacent strokes overlapped. Do not tear the concrete surface when applying the finish. Produce regular corrugations a maximum 1/8-inch (3 mm) deep.

D. Special Tooled Finish. Produce special tooled finishes using a bushhammer, a pick, a crandall, or other approved tool. Use air tools unless otherwise directed. Do not begin tooling until the concrete has set for at least 7 days, or longer if necessary, to prevent "picking" the aggregate out of the surface. Produce a finished surface showing broken aggregate in a matrix of mortar, each aggregate particle being in slight relief.

E. Concrete Bridge Decks. Finish deck slabs by the machine method, excluding small or irregularly shaped areas where a machine is impractical.

1. **Machine Method.** Use a self-propelled transverse finishing machine to strike off and finish the surface of deck-slab concrete. Furnish the Project Manager information on the location and method of rail support, size of rail members, and a description of the machine.

   Trial run the finishing machine over the entire deck area to be finished before placing any concrete. Make the trial run with the machine and rails set to the specified grade and section. Attach a spacer to the bottom of the strike-off 1/8-inch (3 mm) in thickness less than the concrete cover shown in the Contract. Adjust the support rails to compensate for dead-load deflections in the bridge girders. Adjust transverse strike-off support rails to match any changes in the deck section. Make transverse rail adjustments to maintain the specified surface tolerances. Record trial run transverse rail adjustments for use

during the deck finishing operations. Make all adjustments to maintain proper grade, section, concrete cover over slab reinforcement, and slab thickness before any concrete is placed.

While placing the concrete, make enough strike-off passes to produce the required profile and section.

Maintain the heading of concrete placement nearly parallel to and not more than 10 feet (3 m) ahead of the strike-off. The concrete carried ahead of the strike-off must not cause wheel slippage or other unsatisfactory operation.

Orient the transverse axis of the finishing machine parallel to centerline of bearing on all pre-stress and steel girder spans skewed more than 15 degrees. Make the concrete placement heading parallel to the strike-off heading to produce equal loads on each girder.

2. **Hand Finishing.** Obtain the Project Manager's approval for hand finishing on deck slabs.

   Strike off concrete using a template or vibrating screed and finish to a smooth, even surface meeting the required profile and section using longitudinal and transverse floating. Power trowels are not allowed.

3. **Straight-edging.** Test the plastic concrete surface for surface smoothness behind the finishing machine with a 10 foot (3 m) straightedge. Assure the straightedge contacts the surface in successive positions parallel to the centerline of roadway across the entire slab width. Make longitudinal advances in maximum 5 foot (1524 mm) increments.

   Immediately fill depressions with fresh concrete, consolidate, strike off, and finish. Remove high areas with a 10 foot (3 m) cutting straightedge and refinish. Correct all other surface defects using a 10 foot (3 m) float or combination float and cutting straightedge.

   Provide footbridge(s) that clear span the fresh concrete for complete finishing, texturing, curing, straightedge testing, and surface correction.

   Continue straightedge testing and surface correction until the entire surface meets the specified surface-smoothness requirements.

   Limited hand floating may be used to correct defects left by the finishing machine. Hand floating is not required if the machine-finished surface meets surface-smoothness requirements and is free of defects.

4. **Bridge Deck Surface Texture.** Texture the bridge deck surface with transverse grooves while the concrete is plastic. Use a hand or mechanically-operated comb or broom having a single row of steel tines spaced 3/4-inch (20 mm) center-to-center. Use tines of approximately 0.03 inch (1 mm) thick, 0.08 inch wide (2 mm), and from 4 to 6-inches long (105 to 155 mm).

   Operate the handheld texturing device from a footbridge. Make the application, the angle of tines with the surface, and the pressure on the concrete to produce a groove depth of between 1/8 to 3/16-inch (3 to 5 mm) without the grooves flowing together, tearing the surface, or displacing the coarse aggregate.

Do not overlap successive passes of the texturing device.

Terminate grooves 1 foot (305 mm) from the face of any curb or barrier. Skewed bridge decks may be textured parallel to the heading of concrete strike-off and finishing.

The allowable surface smoothness variation is independent of the grooves formed by the transverse texturing.

5. **Broom Texture.** Hand finish the traffic surface of curbs, sidewalks, and other horizontal surfaces to receive a broom finish under Subsection 552.03.12(E)(2). Manipulate the broom to produce a smooth, sealed surface meeting the specified surface-smoothness requirements.

   The texturing broom may be any medium-stiff bristled broom. Broom at right angles to the curb face or sidewalk and produce a uniform close spaced texture not exceeding ⅛" (3 mm) deep.

6. **Surface Smoothness.** The finished surface must not vary more than 1/8-inch (3 mm) from a 10 foot (3 m) straightedge placed parallel to the roadway centerline.

   High spots are measured as one-half the distance between the end of the straightedge and the pavement surface with the straightedge centered on the apex and the opposite end held in contact with the surface. Low spot variations are measured as the distance from the straightedge to the surface with the straightedge centered on the low point. Correct unacceptable surface variations by grinding off high spots and patching or filling low areas.

   Subsequent surface-sealing will not be required where the grooved surface is produced using a diamond-faced saw-type cutter for grinding.

   Perform surface sealing as follows for areas ground using conventional star-wheel-type cutters:

   Seal all areas where removal exceeds 1/4-inch (6 mm) in depth with an approved, concrete-colored, low-viscosity epoxy-resin adhesive. Produce a non-skid texture using a steel-tine broom or by applying medium-coarse silica sand to the plastic epoxy surface. Meet the surface smoothness requirements.

7. **Protective, Remedial, and Corrective Work on Deck Slab Concrete.** Do not place concrete for deck slabs and stop work when rain appears imminent. Take immediate action to strike off all concrete in place to promote drainage and prevent ponding.

   Placing or finishing work that manipulates the concrete will not be allowed during precipitation.

   Deck slabs areas where precipitation has been incorporated into the concrete may be rejected. Make a maximum 3 light passes with a straightedge float to remove excess water after the precipitation stops.

   Protective work is that work necessary to protect unhardened concrete from damage by hail and rain. This includes covering the concrete with a protective covering when conditions warrant.

   Remedial work is that work to restore a surface profile and texture on unhardened, rain-damaged concrete. Concrete damaged by rain to the extent the texture is obliterated and has a sandy appearance may

be repaired by removing excess water and restoring it to the specified surface smoothness and texture.

Hardened concrete is concrete that is non-plastic and does not allow the vibrator to penetrate under its own weight.

Corrective work is work to provide an acceptable profile and texture on hardened, rain-damaged concrete.

Do not place fresh concrete against hardened concrete until a construction joint is placed under Subsection 552.03.7.

Correct areas exceeding the specified surface-smoothness tolerance and areas where the specified texture cannot be produced by grinding and grooving using concrete grinding machines.

Use a diamond saw type grooving machine.

Grooves may be either longitudinal or transverse. Space grooves at 3/4-inch (20 mm) centers and be 1/8-inch (3 mm) wide by 1/8 to 3/16-inch deep (3 to 5 mm).

Grooving is not required on areas that measure 10 feet (3000 mm) or less in length parallel to centerline of roadway.

Do not grind or groove so that concrete cover is reduced over the top reinforcing bars to less than 2-inches (50 mm).

Remove, replace, or overlay areas that cannot be corrected to the required surface smoothness and texture by grinding and grooving. Submit proposed overlay methods in writing to the Project Manager for approval before use.

Remove all latence and hardened, excess concrete from construction joints before placing curbs, barriers, or other concrete.

Furnish all protective, remedial, and corrective work to provide an approved deck slab at Contractor expense.

F. Bridge Seats and Tops of Walls. Bring the concrete at bridge seats and tops of walls up to the required grade elevation, strike off with a straightedge, and float to a smooth, uniform texture.

Slope the concrete surfaces in areas of bridge bearing assemblies to drain water away from the bearing devices as specified.

Bushhammering is permitted only for leveling the concrete surface under the bearing plate and removing latence and loose and foreign material. Bushhammer to produce full, level bearing.

Use steel shims when necessary to bring the masonry plates up to grade. Use shims of the same size as the masonry plate and a minimum 1/4-inch (6 mm) thick. When elastomeric bearing pads are used, perform the beam seat treatment specified in Subsection 556.03.19 using steel shims of the same size as the sole plate except for thickness. Place the shims between the sole plate and the elastomeric pad.

552.03.13 Installation of Expansion and Contraction Joints. Construct expansion and contraction joints meeting the Contract requirements.

A. Open Joints. Construct open joints by inserting and removing a template made of wood, metal, or other approved material. Remove the template without chipping or breaking the concrete corners.

Do not extend reinforcement across an open joint unless specified.

B. Filled Joints. Construct poured expansion joints similar to open joints.

When pre-molded expansion joints are specified, the thickness of installed filler is specified in the Contract. Match the joint filler to the shape and size of the surfaces to be joined and fix it firmly against the existing surface. Do not displace the joint filler while placing concrete.

Where more than one piece of filler is used to cover any joint surface, place the abutting pieces in close contact and join them together with a layer of asphalt-saturated roofing felt. Use a minimum 20 pound (1 kg per m^2) grade roofing felt having one side covered with hot asphalt.

The filled joints will be inspected immediately after the forms are removed. Neatly cut and remove all concrete or mortar that has sealed across the joint. Fill openings in deck slab joints during construction with an approved tar or asphalt as directed.

Place the necessary dowels, load-transfer devices, and other devices as specified.

C. Steel Joints. Fabricate and paint the joints as specified. Assure that the surface in the finished plane is true and free of warping.

Hold joints in the correct position during concrete placement.

Use the openings at expansion joints shown in the Contract, correcting for installation temperature. Maintain the required clearance.

D. Water Stops. Place water stops as specified.

552.03.14 Placing Anchor Bolts. Anchor bolt holes may be drilled or formed.

Form bolt holes by inserting treated wood plugs or metal pipe sleeves into the plastic concrete and withdrawing the devices after the concrete has partially set. Form bolt holes at least 3-inches (75 mm) in diameter to allow for horizontal adjustment.

Drill holes at least 1-inch (25 mm) larger than the diameter of the anchor bolts. Verify hole size before setting the beams.

Assure all anchor bolts for shoe assemblies project above the plane of the substructure concrete to assure full anchor bolt and nut engagement after the final placement of the shoe assemblies.

Fill holes two-thirds full with an approved non-shrink or epoxy grout. Force the bolts down using uniform, even pressure or light blows with a hammer until the grout rises to the top of each hole and the anchor bolt nut rests firmly against the metal shoe or pedestal.

Determine the final anchor bolt locations, making allowance for thermal effects on the superstructure at the time of grouting.

Remove all excess grout, and clean the metal surfaces for painting.

Do not grout anchor bolts in freezing weather.

Make a written request to the use non-shrink or epoxy grout products formulated specifically for use at temperatures below freezing.

Protect bolt holes against damage from ice by filling with a non-evaporating antifreeze solution. Before grouting the bolts, remove the antifreeze and thoroughly flush the holes with clean water.

Anchor bolts for simple spans may be set to the exact location in fresh concrete. Correct all inaccuracies in bolt locations using approved methods at Contractor expense.

552.03.15 Setting Shoes and Bearing Plates. Set shoes and bearing plates under Subsections 556.03.19 and 552.03.12(F).

Place masonry bearing plates on fiber-reinforced pads, sized and positioned to project a minimum of 1/2-inch (15 mm) on all sides of the bearing plates.

552.03.16 Drainage Holes and Weep Holes. Construct drainage holes and weep holes as specified. Place ports and vents for equalizing hydrostatic pressure where required.

Forms for weep holes through concrete may be wood, clay pipe, PVC pipe, concrete drain pipe, wooden boxes, or metal. Remove wooden forms, if used, after the concrete is placed. Paint or galvanize exposed metal drain surfaces as specified.

552.03.17 Pipes, Conduits, and Ducts. Install and rigidly brace pipes, conduits, and ducts encased in concrete before the concrete is placed.

Furnish and install 3-inch (75 mm) length plastic, PVC pipe or approved equal in the bottom slab at the low point of each box girder cell to provide drainage for each cell. Extend the pipe 1/4-inch (6 mm) below the bottom of the slab and flush with the slab's top surface.

552.03.18 Loading of Piers and Abutments. Do not place any superstructure load on finished bents, piers, or abutments until approved. The minimum time before any superstructure load is placed on the substructure is 7 days, unless otherwise approved.

552.03.19 Opening to Traffic. Open concrete deck bridges to traffic only with the Project Manager's approval.

Do not open concrete bridge decks to traffic when the air temperature during the cure period is 50 °F (10 °C) or higher, until one of the following is met:

A. Twenty-one days after placing concrete unless standard strength test results indicate more time is required; or

B. Test results on field-cured test cylinders indicate that at least 90 percent of the required minimum strength has been attained. Two cylinders constitute a test, with the test strength being the average of the strengths of the two individual cylinders.

The Project Manager will determine the opening date when the ambient temperature during the cure period has been lower than 50 °F (10 °C).

552.03.20 Defective Work. Repair or replace all defective work at Contractor expense. Remove and replace the entire section at Contractor expense when the Project Manager determines the repair is not adequate.

552.04 METHOD OF MEASUREMENT. Concrete is measured in cubic yards (cubic meters) from the plan dimensions. Plan quantities will not be re-measured except as specified in Subsection 552.05.

Fillets, scoring's, and chamfers 2-inches (50 mm) or less in the greatest dimension are omitted from the quantity calculations.

No deductions are made for the concrete volume displaced by reinforcing steel, structural steel, prestressed beams, anchor bolts, drains, weep holes, joint fillers, conduits, or junction boxes.

Deductions are made for the concrete volume displaced by timber, steel, and concrete piles. The timber pile volume encased by concrete is assumed as 0.8 cubic foot per linear foot (0.74 m^3 per m) of pile.

When ordered in writing by the Project Manager, concrete quantities placed outside neat lines, are calculated and added for payment.

No measurement is made for forms, falsework, cofferdams, bracing, and the like.

552.05 BASIS OF PAYMENT. Payment for the completed and accepted quantities is made under the following:

A. The calculated quantities involved in changes ordered in writing by the Engineer are added or deducted from the Contract quantities.

B. A re-calculation will be made and the corrected quantity included for payment, in lieu of the Contract quantity, when the Contract quantity of any complete structure element is in error by five percent or more. A complete structure element is the smallest portion of a total structure for which a quantity is included in the Contract. The party to the Contract requesting an adjustment in quantity shall present to the other party three copies of the description and location and recalculated quantities of the structure element that has the quantity error.

C. Classes "AD", "DD", and "BD Modified" concrete placed in bridges are subject to a payment reduction based on lot payment factors under Subsection 551.03.7(C)(1).

Seal concrete, Class "AS" or "DS" is not under the lot payment factors.

The following percentages of the Contract quantity for a structure element are allowed for payment on progress estimates:

1. 40% of superstructure concrete when deck forms are complete in place;
2. 80% when all types of concrete are placed;
3. 85% when curing is complete;
4. 95% when all finishing is complete;
5. 100% when the structure element area is cleaned up to the Engineer's satisfaction.

Pay Item	Pay Unit
Concrete	Cubic Yard (cubic meter)

Payment at the contract unit price is full compensation for all necessary resources to complete the item of work under the Contract.